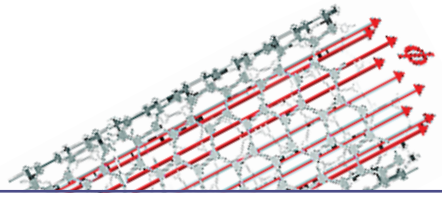
MPA material matters

November 2007



Newsletter of the Materials Physics and Applications Division

Roman Movshovich selected as Laboratory Fellow

Roman Movshovich, MPA-10, has been named a Los Alamos National Laboratory Fellow, the Laboratory's highest scientific recognition of outstanding achievement. Movshovich is being recognized for his important achievements in the field of correlated electron physics.

Roman Movshovich

Movshovich is an internationally recognized leader in low temperature physics whose scientific acumen and innovative thinking have led to significant discoveries and critical insight in elucidating the properties of strongly correlated electron and heavy fermion systems. He has published more than 100 papers that have been cumulatively cited more than 2,200 times.

Movshovich, who earned his PhD in physics from Cornell University, joined the Laboratory as a Director's Postdoctoral Fellow in 1992 and became a member of the technical staff in 1994.

Previous honors include the California Institute of Technology Jack E. Froehlich Memorial Award (1982); Carnation-CIT Prize Scholarship (1982-1983); an AT&T Ph.D. Fellowship (1984-1988); a Los Alamos Achievement Award (1999); a Los Alamos Fellows Prize (2003); and a fellowship of the American Physical Society (2005).

Movschovich's primary research interests lie in areas of heavy-fermion materials, non-Fermi-liquids and quantum critical phenomena, frustrated magnets, unconventional superconductivity, and high temperature superconductivity. His current research is focused on $CeIrIn_5$ and $CeCoIn_5$, the ambient pressure heavy fermion superconductors discovered over the last several years.

INSIDE this issue

CINT's Toni Taylor elected to APS's Division of Laser Science

Center for Integrated Nanotechnologies Co-director Toni Taylor was recently elected to the position of Member-at-Large for the American Physical Society's Division of Laser Science (DLS).

Toni Taylor

The elected members serve for three years. She will attend executive committee meetings at Frontiers in Optics and Laser Science meeting in the fall and the Conference on Lasers and Electro-Optics in the spring where the issues before the DLS are discussed and resolved.

As part of her duties Taylor will provide guidance to the DLS executive committee and will lead various DLS activities.

The APS Division of Laser Science promotes laser science interests within the APS and represents such interests with other societies.

The group also sponsors the Laser Science Conference, the annual meeting of the division; sponsors such awards as the APS Arthur L. Schawlow Prize in Laser Science, and APS fellowship, and a distinguished traveling lecturer program; and a DLS student travel grant program.

MPA-11's Niemeyer recognized for outstanding materials science presentation

MPA-11 student Alyson Niemeyer won the award for outstanding presentation in materials science at the recent Los Alamos National Laboratory student symposium. Niemeyer's talk "High Quantum Efficiency Polymer Photoconductors Using Interdigitated Electrodes," described her work with Brian Crone investigating the photoconductivity in interdigitated lateral photoconductors with aluminum contacts, and a poly[2-methoxy-5-(2-ethylhexyl-oxy)-1,4-phenylene-

"Niemeyer" continued on page 4

From Alex's desk

MPA: Working together during challenging, interesting times

Our institution is going through a very interesting time—interesting due to the current workforce restructuring challenges, but also because of the tremendous opportunities.

Let me first focus on our future as we are all helping to set up Los Alamos National Laboratory's capability for the 21st century. What a great opportunity to face our current challenges and embrace and contribute to our own future as a leading scientific institution.

It is with great enthusiasm that I see our technical and leadership population, at all levels, begin to engage in the making of Los Alamos's signature facility MaRIE (Matter-Radiation Interactions in Extremes) that John Sarrao is leading. We have a bright future and I'm personally honored and excited to have the opportunity to lead MPA Division at this particular time.

The workforce restructuring will be indeed difficult and the impact challenging. But we must, however, do it right and with thoughts on how to shape our workforce for the future. This will not be an easy exercise: we must balance our current needs based on project budgets and keep a very clear vision for the future.

I would like to emphasize, however, that when uncertainty may be running high I urge you to pay additional attention to performing your work safely. Please do not rush and keep your mind focused on the work to be performed.

> What a great opportunity to face our current challenges, and embrace and contribute to our own future as a leading scientific institution.

As a division, we continue to perform very well. From fundamental science to delivering applicable solution to practical problems, we are exceeding on all fronts. I'm really enjoying visiting MPA's groups and centers. It is great to see how well positioned we are to contribute to the future of the institution.

In addition to performing management observation and verification (MOV) visits with local leadership, I enjoy talking to folks, learning more about our technical capabilities, and basically just talking about anything.

I'm also encouraging local leadership to perform cross groups and centers MOVs with the intent to create a common safety and security awareness among the Division's leadership team.

When time allows, I plan to attend group and center meetings—my purpose is to learn about local challenges and do all I can to help get the work done safely and efficiently. If you have suggestions on how to improve communication from the Division Office, please don't hesitate to stop by. David Watkins or I would be delighted to engage in any informal technical discussion or in anything else you may feel in which we could contribute.

We will be soon starting a 15-minute technical presentation during our MPA Council Meeting. The technical talks will give MPA's leadership team a great opportunity to, as a team, even better appreciate the breath of science and capabilities we have within the Division.

This week we'll hear more about MPA-11's fuel cell program and in December we'll have a presentation detailing a polymer-assisted deposition (PAD) growth technique for actinide oxides, a collaboration involving MPA-10, MPA-STC, and MPA-MC. If you have suggestions for subsequent presentations, please let me know. Also, in mid-December I'll be calling an MPA All-Hands Meeting where I plan to present the state of the Division and our near future goals.

In conclusion, the Division is going strong and we need all your help to keep it strong. Thank you again for the opportunity and let's work together to face the institution's challenges.

—Interim MPA Division Leader
Alex H. Lacerda

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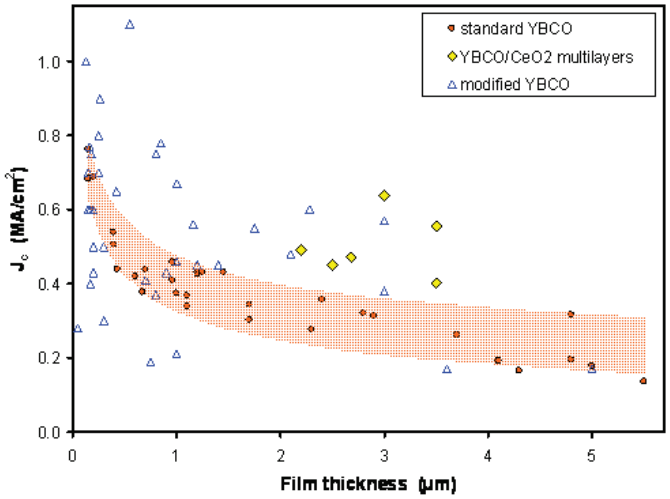
MPA-STC expertise called upon for invited review article published in *Nature Materials*

Twenty years ago in a series of amazing discoveries it was found that a large family of ceramic cuprate materials exhibited superconductivity at temperatures above, and in some cases well above, that of liquid nitrogen. Imaginations were energized by the thought of applications for zero-resistance conductors cooled with an inexpensive and readily available cryogen. Early optimism, however, was soon tempered by the hard realities of these new materials: brittle ceramics are not easily formed into long flexible conductors; high current levels require near-perfect crystallinity; and — the downside of high transition temperature — performance drops rapidly in a magnetic field.

Despite these formidable obstacles, thousands of kilometers of high-temperature superconducting wire have been manufactured for demonstrations of transmission cables, motors and other electrical power components. The question is whether the advantages of superconducting wire, such as efficiency and compactness, can outweigh the disadvantage: cost. The remaining task for materials scientists is to return to the fundamentals and squeeze as much performance as possible from these wonderful and difficult materials.

In "Materials science challenges for high-temperature superconducting wire," published in *Nature Materials* **6**, 631 - 642 (2007), authors Steve Foltyn, Leonardo Civale, Quanxi Jia, Boris Maiorov, and Marty Maley, all MPA-STC; and Judith MacManus-Driscoll, University of Cambridge; and Haiyan Wang, Texas A&M University, review the existing catalogue of process modifications, the defects they produce, and how they impact performance, establishing a methodology for judging the improvement of existing and future efforts in the area.



Critical current density of standard (red) and modified (blue) YBCO films in a magnetic field of 1 tesla. Modifications include substrate surface decoration, incorporation of nanoparticles in the films or use of rare-earth elements in place of yttrium – all aimed at improving performance in a magnetic field by adding flux-pinning defects. The plot shows that, despite claims to the contrary, many of these attempts to enhance the performance of YBCO in a magnetic field have produced results that are no better than standard YBCO.

The work was funded by the Department of Energy's Office of Electricity Delivery and Energy Reliability.

NHMFL's Jaime presents plenary lecture at annual meeting of Argentine physics association

Marcelo Jaime

MPA-NHMFL's Marcelo Jaime presented a plenary lecture at the 92nd Reunión Anual de Asociación Física Argentina, held in Salta, Argentina recently.

Jaime presented "Bose-Einstein Condensation of Magnons and Other Exotic Properties of Magnetic Excitations at High Magnetic Fields," in which he focused on recent results obtained at the National High Magnetic Field Laboratory, including ESR/EPR, magnetostriction, magnetization and specific heat measurement in very high magnetic fields.

The AFA annual meeting brought together more than 500 physicists from Argentina and other Latin American countries and the program includes 10 plenary talks and 12 semi-plenary talks.

Jaime earned his PhD in Bariloche, Argentina, in 1994 and joined the Laboratory in 1997.

MPA-10 GRA nets best poster at GNEP review

MPA-10 Graduate Research Assistant Peter Hosemann received the best poster award presented at the recent Global Nuclear Energy Partnership program (GNEP) annual review in Phoenix.

The poster, "Ion beam irradiation studies on materials" by Hosemann; Stuart Maloy, MST-8; Ning Li, MPA-10; Greg Swadener, MPA-CINT; D. Kiener, University of Leoben, Austria; G.S. Was, University of Michigan; M. Okuniewski, University of Illinois, Champaign-Urbana, summarized recent micro- and nanoscale mechanical testing methods applied to ion beam irradiated materials. Presented were testing techniques, nano-indentation, and micro-compression testing.

Heads UP, MPA!

MPA WSST, your voice in safety and security issues

When you hear the term "safety and security", what is the first thing that pops in your head? If it is "oh man more paperwork and confusing rules" then you are not alone. We all know safety and security are of paramount importance and do our best to see that we and our coworkers stay safe and help protect our nation. But when policies come our way written by the compliance-driven "them," they don't always work so well in our labs and shops. We all have had times where we have filled out paperwork that seemed nearly senseless or that we cannot understand.

In addition to policy issues, there are also those issues that arise that we don't know who to go to about, haven't seen any action on or that seem hopeless to implement.

Worker Safety and Security Teams (WSSTs) have been formed at the institutional, the associate directorate, and the division levels to tackle these very issues on your behalf. The teams are composed of volunteer "workers" (generally lab folks) who work on issues related to safety and security brought to them by their coworkers. Who else knows the hazards and broken policies better than those doing the "work" in the labs? Although all WSSTs have the support of management (group leaders, division leaders, and associate directors) in the form of advice (when requested) and some funding, management, Environment, Safety, Health & Quality (ESH&Q) nor Security are telling us what to work on. This comes from you.

The MPA WSST is working on the ChemLog system (anyone not have complaints about that?), particularly how gas cylinders are tracked, who are the contacts and what forms to use. We are also trying to change some procedures and the forms used, but this may take awhile. These clarifications will not only help MPA, but gas cylinder owners across the Laboratory. We also have been working on Exhibit F requirements (a purchase request-related form for onsite work), getting facility work done, the new x-ray generating device (XGD) requirements, and clarification of just who are our ESH&Q and facility contacts with all the recent organizational changes.

If you have an issue, let us know by going to our website or emailing us at mpawsst@lanl.gov.

On our website we post our meeting minutes and have an action log which is updated every two weeks after our bi-weekly meetings. You can see what we are working on or track your issue.

Your MPA WSST members are:

- Chris Sheehan (chair) – MPA-STC
- Eric Bauer, MPA-10 (ADEPS WSST member also)
- Roger Lujan, MPA -11
- Clay Macomber, MPA-MC
- Chuck Mielke, MPA-NHMFL (ADEPS WSST member also)
- Darrell Roybal, MPA-NHMFL
- Darrick Williams, MPA-CINT

MPA Division Leader John Sarrao is champion for the team and Acting Division Leader Alex Lacerda and Deputy Division Leader David Watkins are on board and supportive.

To check our website see int.lanl.gov/orgs/mpa/mpa_wsst or simply click on the related link on the right side of the MPA home page. The Institutional WSST webpage is http://int.lanl.gov/esh/wsst.

Worker Safety and Security Team Charter

- Serve as points of contact for any worker at the Laboratory with a safety of security concern or idea.
- Track and address individual safety and security concerns raised by the worker, institutional safety or security data.
- Evaluate and recommend improvements for the effectiveness of safety and security activities.
- Achieve a cooperative attitude for a safe and secure environment.
- Review concerns of workers over implementation of proposed policies concerning safety and security.
- Assist in the development of institutional goals, objectives, and measures with regard to safety and security.

Cuprate Fermi orbits and Fermi arcs: the effect of short-range antiferromagnetic order

Since the discovery of high temperature superconductivity in 1986, the existence of a clearly defined low energy electronic structure or "Fermi surface" has remained elusive. Many prominent theoreticians have doubted its existence, leading to exotic descriptions of the ground state and exotic theories of high temperature superconductivity.

Very recently, two groups, one at a high magnetic field laboratory in Toulouse, France, and another here at Los Alamos National Labs have uncovered the first definitive evidence for a well defined Fermi surface in two underdoped high temperature superconducting compounds, showing for the first time a clear commonality between the electronic structure of high temperature superconductors and that of ordinary metals.

The observation of quantum oscillations in $YBa_2Cu_4O_8$ in the 100 tesla magnet in Los Alamos provides unambiguous evidence for a well defined Fermi surface that is modified with respect to that expected from simple electronic band theory. The finding of small pockets of carriers in particular suggests that the Fermi surface is reconstructed within the "pseudogap" regime in a qualitatively similar manner to that in an ordinary antiferromagnet.

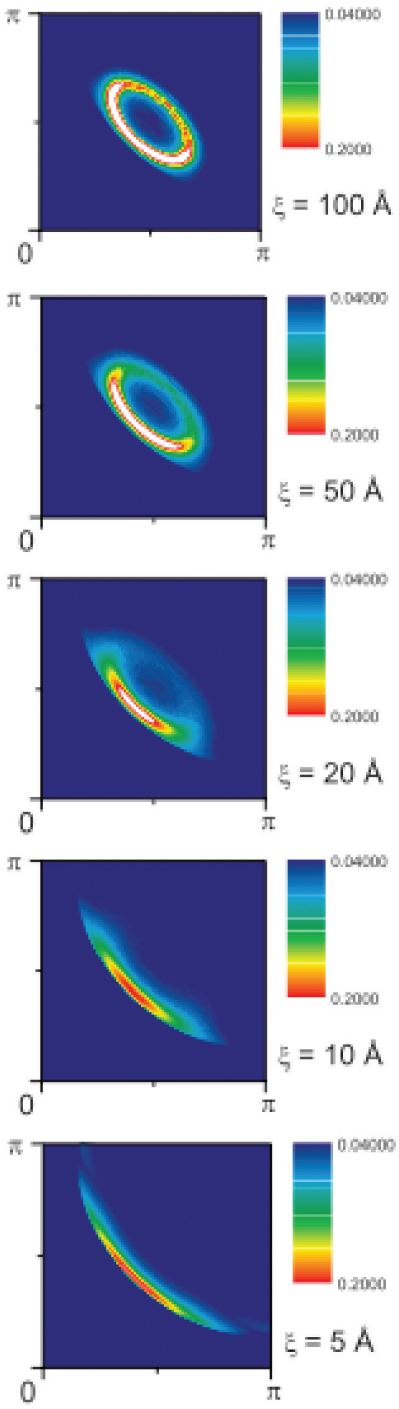
By considering a model antiferromagnetic system in which the correlation length is very short ξ (as shown by neutron scattering studies), MPA-NHMFL's Neil Harrison, Ross McDonald, and John Singleton are able to explain both their observation of small Fermi surface pockets and the previously puzzling observation of "Fermi arcs" in photoemission studies. They use a simple statistical model in which ξ gives rise to a probability distribution for the antiferromagnetic nesting vector Q.

When ξ is very short (i.e. 5-20 Å, corresponding to a wide distribution) they obtain arcs in Fig. 1 reproducing those observed in recent photoemission experiments. When ξ is made longer (i.e. $\xi > 50$ Å) a fully closed pocket is visible with an effective scattering rate that is consistent with quantum oscillation experiments.

These findings (*Physical Review Letters* **99**, 2007) suggest that antiferromagnetism becomes more stable in high magnetic fields, as suggested by recent theoretical models and neutron scattering experiments in weak magnetic fields.

These findings also provide a strong indication that the groundstate of the pseudogap regime is best described in terms of slow antiferromagnetic fluctuations rather than more exotic models. This is an essential prerequisite for identifying the correct theory for high temperature superconductivity.

The research performed at Los Alamos was funded by the Department of Energy, Office of Basic Energy Sciences.



At right, numerically simulated "Fermi surface intensity" plots according to the short range antiferromagnetic correlations model, reproducing those typically obtained from analysis of angle-resolved photoemission spectroscopy data.

"Niemeyer"

Continued from page 1

vinylene] [MEH-PPV]/{6}-1-(3-(methoxycarbonyl) propyl)-{5}-1-phenyl-[6,6]-C61 [PCBM] blend as the active layer.

They demonstrate quantum efficiencies over 70% in 5 mm devices. The absorption in the MEH-PPV/PCBM films can be fit with a linear sum of the absorption of MEH-PPV and PCBM films. The quantum efficiency spectra follows the absorbance spectra for films with optical densities <1.

The quantum efficiency is a monotonically increasing function of applied field. The field dependence can be explained with a modified Onsager model for charge dissociation.

Staff input sought on technical scope for MaRIE

By Karen Kippen

A town hall meeting on MaRIE, the Laboratory's proposed signature experimental facility, drew a large turnout and generated discussion about its pivotal role in the Laboratory's mission and its potential to deliver transformational solutions in support of materials-centric national security science.

MaRIE (Matter-Radiation Interactions in Extremes) is designed to deliver "game-changing advances in national security, energy security, and discovery science," according to MPA Division Leader and capture manager for MaRIE John Sarrao.

The town hall meeting on November 7 was the start of a series of grassroots events scheduled to engage Laboratory researchers in further defining facility specifics.

Laboratory Director Michael Anastasio and Terry Wallace, principal associate director for Science, Technology, and Engineering, announced MaRIE at an all-employee meeting in August

"This is a decade-long challenge for us," Wallace said of the proposed MaRIE facility. "This is going to be a lot of hard work. Not only do we have to internally agree on what this thing is, but we have to be behind this."

Scoping workshop to be held in the Physics Auditorium December 3 and 4. See marie.lanl.gov.

MaRIE vision

Susan Seestrom, associate director for Experimental Physical Sciences (ADEPS), described MaRIE as a "rich, complex facility" at the "high-level concept state" still to be "fleshed-out with details." According to Seestrom, MaRIE is the right facility for Los Alamos and the right concept, even if that concept is more multifaceted than a three-word tag line promising the solution to a single scientific quandary, such as "discover the Higgs" or "achieve ignition in the Laboratory."

MaRIE will be designed to create and exploit extreme radiation fluxes and to probe matter on unprecedented scales, in order to translate discovery science into practical application. The nuclear focus makes MaRIE unique to the Laboratory, said Sarrao, as does the commitment to focus on grand science challenges. "Because we are Los Alamos, these should not be easy, short-term barriers, but rather hard and important problems," said Sarrao.

MaRIE challenges

To fulfill this mission MaRIE will provide three essential capabilities: creating extreme radiation fluxes through a Fission and Fusion Materials Facility and enhancements to the Weapons Neutron Research Facility; providing unprecedented probes of matter through the Multi-Probe Diagnostic Hall and enhancements to the Lujan Center; and translating discovery to solution through M4, a facility dedicated to making, measuring, modeling materials.

Aspects of MaRIE are "deliberately under-specified," said Sarrao, who encouraged staff to communicate their ideas, concerns, and areas of interest to him and a team of capability liaisons. Staff have the opportunity to help define the national-mission needs to be addressed with MaRIE; the revolutionary opportunities for advancing the state of science; the basis for credible Los Alamos leadership in these areas; how MaRIE can make a difference; and how this concept translates to general facility and hardware requirements, said Sarrao.

A scoping workshop will held in the Physics Auditorium on December 3 and 4.

For more details on MaRIE, upcoming events, and links to the specific call for staff input, visit the Web site at marie.lanl.gov.

MaRIE capability liaisons

Paul Follansbee and Doug Fulton,
Experimental Physical Sciences (ADEPS)
Jeanne Robinson, Chemistry,
Life and Earth Sciences (ADCLES)
Ed Kober and Joanne Wendelberger,
Theory, Simulation, and Computation (ADTSC)
Gary Read and John Erickson,
Engineering and Engineering Sciences (ADE)
Dave Funk and Kathi Alexander, Weapons Physics (ADWP)
Randy Erickson and Bruce Carlsten,
Threat Reduction (ADTR)
Kurt Schoenberg, for LANSCE